



Strategic municipal energy planning in Sweden – Examining current energy planning practice and its influence on comprehensive planning

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ABSTRACT

The Swedish municipalities, which possess great autonomy for land use planning, are required to have Energy Plans (EPs) concerning the distribution and supply of energy. However, most municipalities no longer have operational control over these aspects of the energy system. Instead, many municipalities have initiated proactive, strategic energy and climate planning. Prior to a potential legislative revision, the current energy planning practice is examined with regards to the propagation of these different energy planning approaches and the influence of municipal energy planning on comprehensive planning. This study shows that 61% of Sweden's 290 municipalities adopted an EP during 2004–2015. Most of these EPs had a broad scope, and it is shown that during the studied time frame the focus of the municipal energy planning gradually shifted towards mitigating climate change. The municipalities' population size also has a significant effect on the propagation and currentness of energy planning. Furthermore, municipal energy and climate planning increases the potential for ensuring the consideration of energy and climate targets and strategies in comprehensive planning, which can facilitate a more sustainability-led municipal planning in line with the Swedish energy and climate objectives, and this relation is thus urged to be strengthened.

1. Introduction

In light of the rapid and ongoing changes to the world's climate, there is an urgent need to facilitate the transition from fossil fuels to renewable energy sources and to improve the efficiency of energy use (International Energy Agency, 2015; IPCC, 2011). The Paris Agreement is a milestone in global climate policy due to its wide international support (Fragkos et al., 2017). However, the emission reductions pledged by the parties lead to a trajectory towards a global warming of 2.6–3.1 °C above pre-industrial levels in 2100, and additional action will be needed from a variety of actors at different levels in order to reach the target of staying well below 2 °C and pursuing efforts to limit the global warming to 1.5 °C (Rogelj et al., 2016). Local communities or municipalities are one of these actors, as local action is seen as key to combating climate change (UN, 1992), and energy and climate planning at the municipal level is a vital part of this decarbonisation (Damso et al., 2016; Pasimeni et al., 2014; van Staden and Musco, 2010). In order to mitigate climate change, the member states of the European Union (EU) have agreed upon emission reduction targets as well as targets regarding energy efficiency and the share of renewables (Strambo et al., 2015). Based on these EU climate targets, and in order

to implement the Renewable Energy Directive (EU Directive 2009/28/EC) and the Energy Efficiency Directive (EU Directive 2012/27/EU) of the EU, the government of Sweden has established national targets for 2020 covering emissions of greenhouse gases (GHGs), the share of renewable energy (both in total and specifically for the transport sector), and energy efficiency (Government Bill 2008/09:162; Government Bill 2008/09:1639). Moreover, on June 2017, the Swedish Parliament adopted a new climate policy framework, further advancing Sweden's ambitions on climate change mitigation (Government and Government Offices of Sweden, 2017). The new long-term, overarching objective is to reach zero net emissions of GHGs in 2045, with interim targets for the so-called ESR-sectors (i.e. the sectors falling outside of the EU Emissions Trading Scheme, including sectors such as transport, buildings, agriculture, and waste management), aiming for a decrease in GHG emissions by 63% in 2030 and by 75% in 2040 compared to the baseline levels of 1990 (Government Bill 2016/17:146). Another milestone target is for domestic transport (excluding domestic aviation) for which emissions should be reduced by 70% until 2030, compared to the emissions in 2010 (Government Bill 2016/17:146). It has recently been assessed that Sweden's 2020 targets will be met with the current policy instruments (Official Letter 2015/16:87), whereas it has been

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prognosticated that the target regarding fossil fuel independency in 2045 will not be reached without tightening current legislation and policy instruments as well as introducing new ones (Swedish Environmental Protection Agency, 2015). Nor the required emissions reductions within the transport sector is predicted to be achieved with currently planned measures and instruments (Månsson, 2016; Swedish Transport Administration, 2015).

The Swedish municipalities are often seen as vital actors in implementing energy policies (Fenton et al., 2015; Palm, 2006) as well as for making further efforts in the energy and climate sector due to their broad and extensive operations and responsibilities concerning planning and decision-making (Granberg and Elander, 2007; Swedish Environmental Protection Agency, 2012). According to the Act on Municipal Energy Planning (1977:439), all Swedish municipalities are required to have an Energy Plan (EP) concerning the supply and distribution of energy. However, since the implementation of the Act, many municipalities have lost operational influence over these provisioning aspects of the energy system (Stenlund Nilsson Ivner, 2006), and some municipalities have instead initiated proactive energy and climate planning by developing Energy and Climate Strategies (ECSs) aiming at lowering GHG emissions (Gustafsson et al., 2015). Some previous studies have been conducted regarding the propagation of municipal EPs and ECSs in the Swedish context (e.g. Gustafsson et al., 2011; Swedish Energy Agency, 2011; Swedish Environmental Protection Agency, 2010). However, all of the studies with a broader selection of municipalities have conducted their investigations through surveys where the participation tends to be skewed towards more active municipalities and the respondents might possess an interpretive bias (Damso et al., 2016; Salon et al., 2014). Moreover, these mappings were conducted a couple of years ago, and some economic incentives (e.g. the Energy Efficiency Subsidy) have been put into effect since then. Hence, a more thorough examination and mapping of current energy planning practice is needed in order to provide insights when considering the future direction of municipal energy planning in Sweden and prior to a potential revision of the Act on Municipal Energy Planning, which is currently being discussed. Further, it is suggested by van Staden and Musco (2010) that smaller local communities often have more limited resources for local climate action, e.g. in terms of staff capacity and financial resources, and an examination of the effect of population size on the continuity and propagation of municipal energy planning might validate these claims.

Another feature that highlights the municipalities' role in shaping a sustainable society is that they have the main responsibility for planning the use of land and water within their geographical area (Elbakidze et al., 2015). Due to this high level of municipal autonomy, the Comprehensive Plan (CP) is a key element in the Swedish planning system (Persson, 2013). Because spatial planning can influence energy use in transport, housing, and the production of renewable energy, there is a need for considering these perspectives in comprehensive planning (Lundström, 2010; Ranhagen, 2013). Therefore, it is of interest to investigate if energy planning can promote the inclusion of targets or strategies concerning energy and climate in comprehensive planning.

The overall aim of this paper was to examine current energy planning practice at the municipal level in Sweden as well as its influence on municipal comprehensive planning. To accomplish this, two specific aims were set:

1. Map, analyse and discuss the propagation, function and use of Energy Planning Documents during 2004–2015.
2. Analyse and discuss the influence of municipal energy planning on municipal comprehensive planning concerning targets and strategies relating to energy and climate issues.

In this paper, the term Energy Planning Document (EPD) will be used as an umbrella term covering all municipal policy documents with

a focus on energy and climate, regardless of whether it is an Energy Plan or not.

2. Background

2.1. Energy planning in Sweden

Besides the responsibility for spatial planning, the Swedish municipalities are required to have a municipal EP concerning the supply, distribution, and use of energy according to the Act on Municipal Energy Planning from 1977 (1977:439). This legislation was developed in a time of energy crisis in order to secure the energy supply (Government Bill 1975:30). The Act is described as a soft regulation by Lundqvist and Kasa (2016) because it lacks both distinct time frames and a clear connection to the municipal land use planning, and no authority was tasked with supervising the municipal implementation of the Act. After the deregulation of the Swedish electricity market in 1996, however, many municipalities either sold or privatised their municipal energy companies (Högselius and Kaijser, 2010; Stenlund Nilsson Ivner, 2006). Since then, many municipalities have been somewhat inhibited in their energy planning regarding supply and distribution because they have limited ability to influence these aspects of the energy system (Olerup, 2000; Palm, 2004).

Swedish energy policy shifted focus from oil reduction to the phase-out of nuclear power in the mid-1980s, and from the late 1990s there has been a growing recognition of the need to emphasise climate change and for shifting towards an energy system based on renewables (Nilsson and Mårtensson, 2003). This resembles the history of broader trends within EU energy policy, with emphasis put on securing supply from the 1970s and the emergent consideration of climate change in the 1990s, although with nuclear policies varying widely among the member states (Kanellakis et al., 2013). There has seemingly been a synergistic relationship between Sweden and the EU within climate change mitigation policy in the 2000s. The EU through its 2020 climate and energy package has induced national efforts in Sweden through binding targets and national action plans concerning renewable energy and energy efficiency (Kanellakis et al., 2013), and Sweden simultaneously often being in the forefront in terms of targets and emissions reductions. The shift of focus from energy supply to climate change mitigation within Swedish national energy policy has, however, not been reflected within legislation concerning municipal energy planning. Instead, in order to initiate a proactive municipal climate and energy planning, many state-funded programmes providing financial incentives for facilitating the municipalities' energy and climate work were initiated in the 2000s, in which the development of ECSs has been encouraged (Gustafsson et al., 2015). Three such programmes were i) the Climate Investment Programme (KLIMP) (2003–2012), which was administered by the Swedish Environmental Protection Agency and required a Climate Strategy in order to get funding for the implementation of measures (Azevedo et al., 2013; Swedish Environmental Protection Agency, 2013), ii) Sustainable Municipality (2003–2014), which was run by the Swedish Energy Agency in order to strengthen local practices, where the development of ECSs was promoted (Gustafsson et al., 2011; Ranhagen, 2011), and iii) the Energy Efficiency Subsidy (2010–2014), which provided subsidies for strategic energy efficiency work as a part of fulfilling the obligations in the EU's Energy Efficiency Directive (Swedish Energy Agency, 2015a; Swedish Government Official Reports 2008:110). A requirement for obtaining this subsidy, which 270 of 290 municipalities did, was that the municipality had to develop an Energy Efficiency Strategy that focused on the municipality's internal organisation, with targets and an action plan (2009:1533; Swedish Energy Agency, 2015b).

Apart from these policy mechanisms where financial incentives were provided, some 'softer' policy mechanisms focusing on raising awareness have also been in place both at the EU and the national level (Azevedo et al., 2013). Europe-wide, the most notable initiative of this

kind is the Covenant of Mayors, to which local communities since 2008 can pledge emissions reductions at least mirroring the EU's climate targets for 2020 and 2030 and, if so, present their intended pathway to reach the targets in a Sustainable Energy and Climate Action Plan (Covenant of Mayors for Climate and Energy, 2017a). There are 58 Swedish signatories to the Covenant of Mayors representing half of the Swedish population as of August 2017 (Covenant of Mayors for Climate and Energy, 2017b). Within Sweden, a similar voluntary network called the Climate Municipalities (Klimatkommunerna) has been in place since 2003, where the participating municipalities can get support in their efforts to mitigate climate change (Granberg and Elander, 2007). The Climate Municipalities has requirements similar to Covenant of Mayors, i.e. an inventory of GHG emissions, emissions reduction targets, and an action plan (Klimatkommunerna, 2015).

Since 2007, the County Administrative Boards (CABs) are instructed to develop Regional Climate and Energy Strategies in cooperation with relevant stakeholders, such as municipalities, with the aim of transitioning to a sustainable energy system (Palm and Thoreson, 2014). Hence, the strategic energy and climate work by the CABs might affect the municipal energy planning.

The Swedish Energy Agency undertook an investigation of the Act on Municipal Energy Planning and presented their position in a report from 2011. In this report, the Swedish Energy Agency (2011) shares the view of Olerup (2000), Palm (2004), and Stenlund Nilsson Ivner (2006), who state that the Act on Municipal Energy Planning is outdated and needs to be revised. The rationale for this is that the preconditions on which the Act stands in part no longer exist and that the proactive climate work that the municipalities conduct is thus not reflected in the current legislation (Swedish Energy Agency, 2011). The proposal of the Swedish Energy Agency is to revise the Act to instead require municipal ECSs, which focus on measures that the municipality can perform depending on their ability to exert influence in different matters. Further, it is stated in the report that all Energy and Climate Strategies should have a similar content, including a description of the current energy situation, targets, an action plan, and a plan for follow-up, among others. Consequently, it is urged by the Swedish Energy Agency (2011) that the municipal ECS should be considered by the city council at least once during each term of office. It is now up to the Swedish government to decide on how to progress in this legislative matter.

2.2. Municipal comprehensive planning and its relation to energy and climate aspects

It is stated in the Planning and Building Act (2010:900) that the municipal Comprehensive Plan shall give directions for the long-term development of the spatial environment. The CP is however commonly not only seen as regulating the use of land and water, but also as a visionary document where the municipality's overall development is anticipated (Swedish Association of Local Authorities and Regions, 2014). Hence, the plan is intended to be strategic (Persson, 2013). Furthermore, the CP should show how the municipality intends to consider national and regional objectives, plans, and programmes that are relevant for sustainable development and how it intends to co-ordinate them with the spatial planning (2010:900). The concept of sustainable development is, however, seldom concretised in the CPs, and climate is rarely mentioned in relation to sustainable development (Persson, 2013). Thus there is a need to increase the consideration of energy and climate issues in the CPs, and this could potentially be achieved if there were to be a distinct relation between energy planning and comprehensive planning.

Spatial planning can affect energy use in many different ways. For example, the urban form can impact the transportation needs (Anderson et al., 1996), and planning for physical areas suitable for large-scale wind or solar power generation is another factor that can affect energy use and GHG emissions (Kaza and Curtis, 2014). Although

the Comprehensive Plan provides guidance for future development, it is not binding from a legal perspective. However, it is discussed by Henning and Danestig (2008) that if some declarations of intent regarding energy use are included in these policy documents, it will make it more likely that these matters are taken into account in the legally binding Detailed Development Plans. Due to a legislative amendment (2014:900) to the Planning and Building Act (2010:900), municipalities are essentially not allowed to impose any technical requirements besides the location and form of the proposed constructions, which deprives the municipalities of the possibility to set requirements regarding energy use, energy production, etcetera. This consequently makes spatially associated measures more central as a tool in order to address energy and climate issues.

3. Methods

This study took a mixed-methods approach, achieving the specific aims using triangulation with both quantitative and qualitative methods (Bryman, 2012). The quantitative data were used to map the current state regarding the specific aims, and qualitative interviews were conducted in order to cross-check the quantitative data as well as to gain in-depth knowledge regarding the planning process, the view of the energy planning officials and the use of the EPDs in their daily work.

3.1. Quantitative mapping of current Energy Planning Documents

The main dataset, containing municipal Energy Plans and Comprehensive Plans during the time period 2004–2014, was obtained from a parallel research project called Strategic Planning and Environmental Assessment Knowledge (SPEAK, 2015). According to a study by Gustafsson et al. (2015), municipal energy planning includes many different types of strategic documents directed towards energy production and use at the local level, and thus the content of many municipal Energy and Climate Strategies and Energy Plans can overlap. In order to gain a comprehensive understanding of the current practice, the selection approach of Gustafsson et al. (2015) was followed in this study. The original dataset was thus supplemented with other policy documents concerning energy and climate (e.g. ECSs) for the whole time period, as well as EPs and CPs from 2015. The supplementary collection followed the method from SPEAK (Wallström, 2015), namely to scan the municipalities' websites and then to contact them if the existence of those documents could not be determined through the website.

The collected documents were classified in order to identify the common practice, using the software Nvivo for data analysis (QSR International, 2012). At first, all of the EPDs were briefly analysed to extract some descriptive statistics. For each document, the following data were recorded:

- Which municipality had developed and adopted the document
- In what year the document was adopted
- The title of the document
- Whether it was a municipal EP as referred to in the Act on Municipal Energy Planning
- The type of document

The year of adoption refers to the year the municipal council politically adopted the EPD, if this information was accessible. Otherwise, any sort of temporal reference within the document was used. If the document was named "Energy Plan" or some variation thereof, it was assumed to be a municipal EP, as well as if it was expressed in writing that the document should function as an Energy Plan. All EPDs were classified into three different types. All of the plans with the title of "Energy Plan" were placed in the category of Traditional Energy Plans (TEPs). All policy documents that were functioning as EPs according to

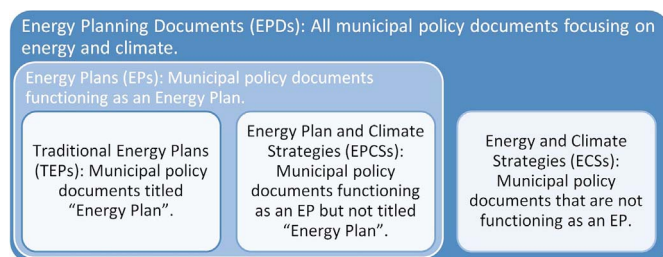


Fig. 1. Explanation and relation of terminology.

the Act but whose title was not just “Energy Plan” were classified as Energy Plans and Climate Strategies (EPCSs), as this indicated that they had a widened scope that was not limited only to traditional energy planning. The other policy documents with a focus on energy and climate but that were not functioning as an EP were categorised as Energy and Climate Strategies (ECSs). See Fig. 1 for a schematic overview of the terminology and its interrelations. It should be noted that neither the content nor the quality of the policy documents were assessed. If several documents of the EP or ECS types were found for the same municipality, only the newest ones of the same type were included in the results. EPDs only addressing activities of the internal organisation were excluded from the study.

Apart from some descriptive statistics, the relation between population size and the propagation and the currentness of the EPDs was examined through the statistical software R (R Core Team, 2017). More detailed information concerning the statistical evaluations can be found in Appendix B.

3.2. Influence of energy planning on comprehensive planning

To investigate the influence of energy planning on comprehensive planning, the CPs that had been adopted within three years after an EPD had been adopted were selected for further analysis along with the corresponding EPDs. This amounted to 36 municipalities. The analysis took an iterative approach, where the analytical framework was updated as tendencies and trends emerged during the exploration of the policy documents.

First, the CPs were analysed, looking for quantitative and qualitative targets or strategies concerning energy and/or climate change mitigation. These targets or strategies were of either quantitative or qualitative character and could either be found in a section of more overarching type – concerning the vision, targets, and/or strategies – or in a section of a more sectorial type, concerning energy and/or climate. The analysis was broad when searching for the targets and strategies, and the only main requirement was that it needed to be made clear that this target was endorsed by the municipality. These targets could be thematised into eight overarching types, with some examples presented in Table 2. Any occurrence of references to the EPD in the CP was also noted.

Next, the corresponding EPDs were analysed, searching for the energy and climate-related targets or strategies that were found in the CP in order to determine if the targets could have originated from the EPD. For the quantitative targets to be counted, they needed to match in terms of values and time frames. For the qualitative targets, it was merely required that the meaning of the target or strategy was the

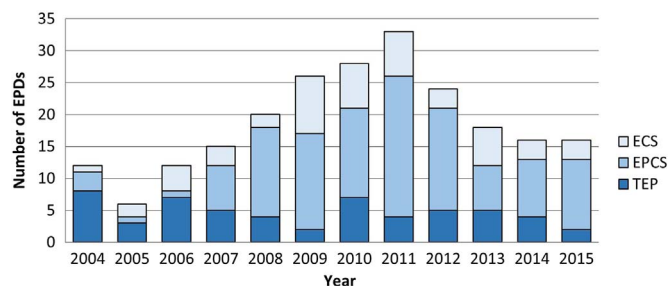


Fig. 2. Number and type of EPD per year.

same. If a qualitative target in the CP had a corresponding quantitative target in the EPD, this was sufficient to be counted.

Any stated links between energy and/or climate change mitigation and land use planning were also noted. These links could be made to different types of municipal planning and still be counted, e.g. to comprehensive planning, detailed development planning, physical planning, and/or land use planning in general. The common denominator for these links was that some standpoints, strategies, or targets formulated in the EPD explicitly involved land use planning in some sense. Five themes were identified, which can be seen along with some examples of identified links in Table 3.

3.3. Interviews

Interviews were held with energy planners and other planning practitioners from eight municipalities. The interviews were semi-structured (Kvale, 2014), and used an interview guide with open-ended questions. The municipalities interviewed in this study were selected because they represented good learning examples of different aspects of energy planning. Five municipalities with an EPD adopted within 2014–2015 and that fulfilled at least one of the following criteria were chosen: having conducted a Strategic Environmental Assessment (municipality B, D, and F), having a holistic approach, including for example a waste or consumption perspective (A and B), or having set progressive goals (H). Three other municipalities that had adopted a CP in 2013 or later and that had adopted an EPD within three years prior to the CP were chosen for having clearly integrated energy issues in their comprehensive planning (C, E, and G). The interviews were approximately one hour, and all took place at the interviewees' workplace except for one conducted by telephone.

The interviews were recorded and then transcribed. The results from the interviews are summarised in Tables A1 and A2 in appendix A, and some of the main findings from the thematic analysis are presented in the results Section 4.2.

4. Results

4.1. Quantitative results

4.1.1. Mapping of Energy Planning Documents

As can be seen in Table 1, 73% of the municipalities had adopted at least one EPD within the study period. Furthermore, it is shown that 176 municipalities (61%) had an Energy Plan as referred to in the Act on Municipal Energy Planning, out of which 56 had adopted a TEP and

Table 1
Number and share of municipalities with different EPDs during 2004–2015.

	Municipalities with EP	Whereof TEPs	Whereof EPCSs	Municipalities with ECS	Municipalities with EPD	Municipalities with EPD adopted in 2010–2015
Number	176	56	120	50	213	135
Share	61%	19%	41%	17%	73%	47%

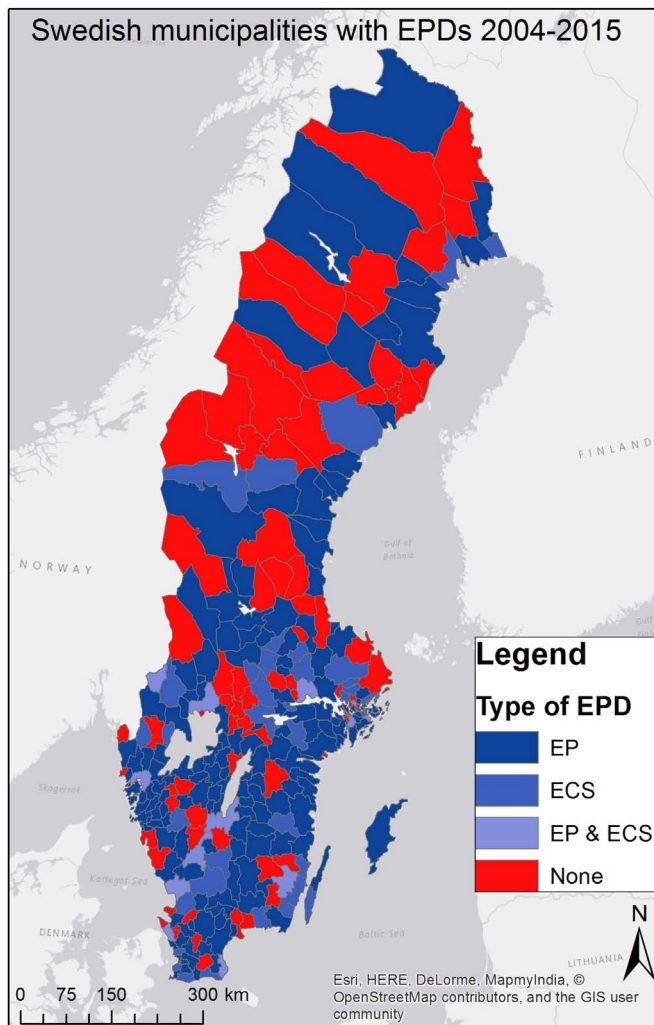


Fig. 3. Visualisation of adopted Energy Planning Documents during 2004–2015.

120 had adopted an EPCS (Table 1). There were two EPCSs that were developed through inter-municipal cooperation, including one with two municipalities and one with three municipalities.

As presented in Appendix B, a Wilcoxon rank-sum test showed that the population size was greater for municipalities that had adopted at least one EPD during the studied time span (median = 18 505) than for the municipalities that did not adopt any EPD (median = 11 943) ($p = 0.00024$). Furthermore, the same statistical tool provided that out of the municipalities that have adopted at least one EPD, the population size was larger for municipalities with an EPD adopted during 2010–2015 (median = 23 915) compared to municipalities with an EPD adopted during 2004–2009 (median = 14 252) ($p = 0.003$). In other words, the results show that municipalities with larger populations were more likely to have an EPD, and also that this EPD have a higher likelihood of being more up-to-date. Fig. 2 shows that the majority of the EPDs were adopted in 2009–2011, followed by a downward trend. Over time, a relative increase in the adoption of EPCSs and ECSs in relation to TEPs can be discerned, especially from 2007 onward (Fig. 2).

The municipalities without any adopted EPDs within the time period were fairly evenly spread over the country, but the majority tended to be clustered in the northern parts of Sweden, which is further highlighted by the fact that three of the four counties with the lowest share of municipalities with an EPD are found there (Fig. 3). The county with the highest share of municipalities that had adopted an EPD was Gotland, but it should be noted that it only consists of one municipality.

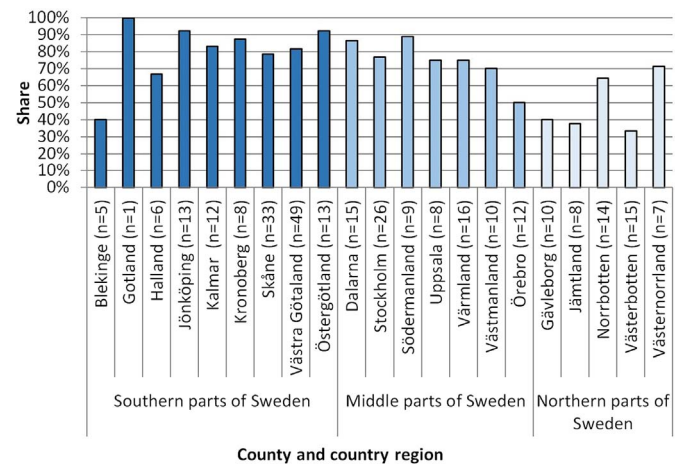


Fig. 4. Share of municipalities with at least one EPD, divided per county and country region (Statistics Sweden, 2016).

Regarding other counties with the highest shares, two of them are found in the southern part and one is situated in the middle part of Sweden (Fig. 4).

4.1.2. Relation between energy planning and comprehensive planning

The analysis of a selection of CPs and EPDs showed that the vast majority (89%) of the analysed CPs include targets or strategies regarding energy and climate, and 97% refer to the preceding EPD (Fig. 5). Of the CPs that include energy and climate-related targets or strategies, 50% of them have targets or strategies of a qualitative nature, 9% have targets of a quantitative nature, and 41% have a mixture of qualitative and quantitative targets and strategies. Fig. 5 further shows that there are often targets and/or strategies that correspond to some of the targets and strategies found in the CP, especially if they are of a quantitative sort. The most commonly identified theme of the targets and strategies in the CPs concerned renewable energy (86%), followed by reduced GHG emissions (58%) (Table 2). It should be remembered that these are merely of a strategic nature and represent the municipalities' intentions, the implementation and adherence to the targets and strategies have not been investigated.

A total of 69% of the preceding EPDs contained some type of explicit link between energy and climate aspects and land use planning. According to Table 3, the most common theme was to broadly state that energy and climate-related issues should function as a basis for some form of land use planning, for example, comprehensive planning or detailed development planning (56%). The theme of energy-efficient transportation was the second most common (53%).

4.2. Results from the interviews

A summary of the interviews is shown in Appendix A in Tables A1 and A2. However, some major highlights will be provided in this section.

4.2.1. Function and usefulness of the Energy Planning Document

Almost all of the interviewees stated that the EPD makes a difference because it is a politically adopted document that should function as a reference basis for municipal energy and housing companies and co-workers in their daily work. The wide political support was mentioned by the interviewees from municipalities D and H as a key factor for implementing the EPD. Three interviewees (B, D, and F) noted that for municipal officials who want to act and take measures to reduce emissions, it helps to have an adopted document that supports such actions. All the interviewed municipalities have thus moved away from the traditional form of energy planning as regulated by the Act.

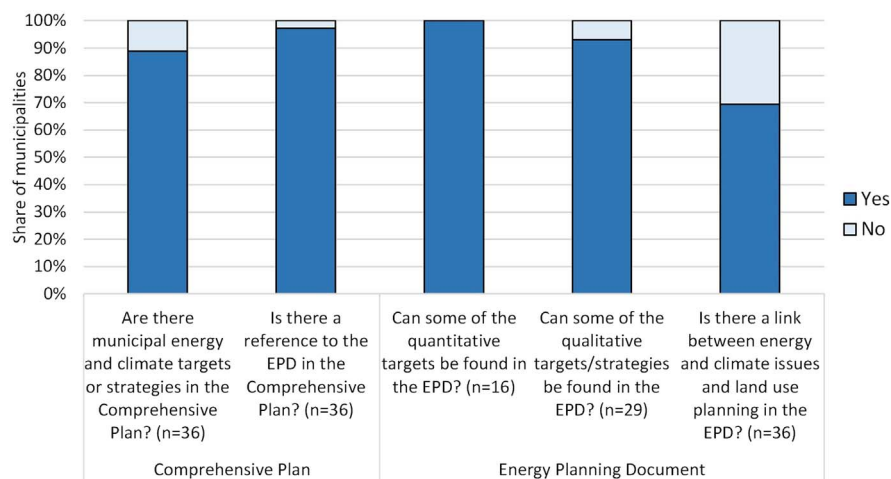


Fig. 5. The relation between comprehensive planning and energy planning.

Table 2
Energy and climate-related targets or strategies identified in CPs (examples translated from Swedish).

Types of targets and/or strategies	Example	Number of CPs with the target/strategy	Share of CPs with the target/strategy
Renewable energy	The share of renewables of the total energy use should amount to at least 50% in 2012 (Kil Municipality, 2008)	31	86%
Reduced GHG emissions	Säter municipality shall reduce its carbon dioxide emissions by 25% by 2020 (Säter Municipality, 2010)	21	58%
Energy efficiency	Overarching target 1: use energy efficiently (Aneby Municipality, 2011)	19	53%
Energy-efficient transportation	The energy use in transportation should be environmentally adapted and more efficient. The share of environmentally friendly modes of transportation should increase compared to 2009. The use of alternative fuels should be facilitated. (Jokkmokk Municipality, 2009)	19	53%
Plan for sustainable forms of heating	What do we want?...? Continuously develop district heating as an attractive form of heating, both environmentally and economically (Finspång Municipality, 2009)	15	42%
Basis for land use planning	In all urban planning there shall be a focus on long-term sustainability and efficient use of energy (Hjo Municipality, 2007)	11	31%
Energy-efficient housing and buildings	Energy requirements: Trollhättan municipality is since February 2010 setting energy demands for new constructions...Buildings should, among other things, have 30% less energy use than required by the Building Regulations (BBR). (Trollhättan Municipality, 2012)	9	25%
Secure energy provision	The municipality's intentions:... Promote a secure energy supply in terms of both production and distribution. (Forshaga Municipality, 2009)	8	22%

Table 3
Links between energy and climate aspects and land use planning in general (examples translated from Swedish).

Type of link to land use planning	Example	Number of EPDs with the link	Share of EPDs with the link
Basis for land use planning	In 2010, all physical planning and urban development should be based on programmes and strategies for how energy is used more efficiently, how renewable energy sources can be utilised, and how expansion of production facilities for district heating, solar power, biofuels, and wind power can be promoted. (Finspång Municipality, 2009)	20	56%
Energy-efficient transportation	The physical planning in Nässjö should strive for an urban structure that minimises the need of transportation. The possibility to walk, bike, and travel by public transport should be promoted in the land use planning. (Nässjö Municipality, 2012)	19	53%
Plan for sustainable forms of heating	Sustainable land use planning ...By considering energy and climate aspects in planning of new residential and commercial buildings one can create a sustainable use of energy for the future. Buildings can, for example, be localised in areas that due to sun and wind conditions have lower heating demands. Settlements can also be placed where favourable preconditions for local environmentally friendly energy production exists, or where possibility to connect to district heating exists. (Orust Municipality, 2007)	14	39%
Plan for production of renewable energy	Establishment of wind farms: The aim is to clarify the preconditions for the establishment of wind farms. Show suitable areas for wind farms in the Comprehensive Plan. (Nyköping Municipality, 2010)	10	28%
Energy-efficient housing and buildings	Municipal decisions and comprehensive planning...Clear and high demands on energy should be imposed on those who want to exploit the municipal land. (Hultsfred Municipality, 2008)	9	25%

Follow-up on the EPD is made in some way for all municipalities except one, and municipalities C, D, E, and H expressed that the follow-up is performed annually. Interviewee D said that the plan should be considered by the municipal council at least once during each term of office, just as the CP should be according to the Planning and Building Act.

All of the municipalities that were selected for interviews except municipality C participated in or were planning to apply for participation in voluntary initiatives where no funding was granted. Most notably was the Covenant of Mayors, which municipalities A, B, D, and E have committed to and municipalities G and H were planning to commit to, and the association Climate Municipalities (Klimatkommunerna), with municipality B, D, E, and H as members of the association and municipality A reviewing the possibility to join.

4.2.2. The planning process

The interviewees expressed various reasons for having started the EPD process. According to interviewees A, D and E1, the municipality needed to develop a new EPD in order to be able to receive government funds. However, four other interviewees (B, C, G, and H) stated that it was initiated due to political will, while interviewee F found that there was a need for an EPD in order to be able to carry through any measures, and hence the process in municipality F was started based on an individual initiative.

According to the interviews, all municipalities' EPDs were developed by forming working groups with municipal officials from other relevant administrations, for example, the technical and environmental administrations, as well as the administration for the built environment. A political steering group was involved in the process according to interviewees F, G, and H. The local energy companies were participating in all processes except one (municipality F), regardless of whether the company was municipally owned or a private actor. Municipal housing companies were also often involved, and other external companies were consulted in at least three of the eight municipalities. NGOs and researchers participated in the process in municipality B, and NGOs were often included during the circulation of comments in the other municipalities. Further, municipality H had a citizen dialogue that led to input and justification for some of the suggested measures.

The CABs and their Regional Climate and Energy Strategies have influence over the municipal planning processes for the interviewed municipalities, especially for setting targets and strategies. Three municipalities (A, F, and G) based their targets and strategies on the regional strategy, and interviewee G stated that the county helped to set up the planning process and produce content. Three other municipalities (C, E, and H) were also influenced by regional targets. All but two municipalities considered the national targets, and municipality E, G, and H even stated that these were sharpened when developing their own targets. According to the interviewees, targets on the EU-level were seldom directly addressed, albeit they are implicitly considered when the municipalities are considering national targets. For municipality D however, the pledged target towards Covenant of Mayors was highlighted as the overarching target of their TEP, and the municipality is thus emphasising its responsibility towards the European Union. Municipalities B, D, and E focused their strategies and measures only on things that the municipality itself can influence and control.

4.2.3. Relation to comprehensive planning

According to the interviews, all municipalities in the study include strategies or measures connected to land use planning in their EPD, with the intention that the strategies or measures shall be integrated in future CPs. The strategies and measures are often linked to the localisation of new developments and transportation, and many interviewees expressed that transportation is the biggest challenge in terms of GHG emissions.

However, this endeavour to localise new development with the intent to minimise transportation and energy use does not come without

resistance within the municipal organisation. Interviewee E2, a planning architect, reported that there is a force within the municipality that wants to be able to provide housing lots in attractive, more secluded locations in order to attract new inhabitants, but this will contribute to urban sprawl and a higher transportation demand.

Seven interviewees (A, C, D, E1, F, G, and H) stated that the EPD to some degree was developed in collaboration with spatial planners. Interviewees A, C, D, E1, and H were also involved in developing the municipality's CP to some degree. In the EPD of municipality H, appropriate areas for densification were chosen with the intent to develop the city towards energy and transport efficiency, which then were used as immediate input in the CP.

4.2.4. Reflections regarding municipal energy planning

The interviewees in the study expressed different experiences of barriers and opportunities for achieving strategic energy planning in the municipality. Interviewees F and G considered the lack of co-operation between different departments within the municipality to be a barrier for effective strategic energy planning. Further, interviewees A and H believed that wide support for the EPD within the different departments is essential for successful energy planning. Three interviewees (B, C, and E) emphasised the importance of having municipally owned energy companies and housing companies so that the municipality can have more control over for example the choice of energy sources for electricity and heating. In contrast, interviewee G expressed that the municipality's possibility to steer the municipal companies is rather limited, even if it appears that the EPD can influence them indirectly. Interviewees D and G stated that it can be difficult to influence the energy use and GHG emissions throughout the entire geographical area of the municipality.

Economic issues are another area of concern regarding municipal energy planning. Interviewees B and E1 mentioned that the economic reality makes it difficult to achieve a transition to renewable energy sources, especially because the municipality is required to be profitable. According to Interviewee D, the municipalities are dependent on financial instruments from the government, and the potential in addressing energy and climate issue lies in knowing that these financial instruments are long-term because this facilitates the municipal concern in implementing measures.

All of the interviewees expressed that the Act on Municipal Energy Planning is outdated or that it needs to be revised. They felt that the sustainability perspective of energy planning should be more thoroughly emphasised in the legislation, such as minimising the impact on climate and other environmental aspects, which is what they are focusing their planning on. However, interviewees C and H said that they are positive to the Act, as it provides an incentive to conduct at least some type of local energy and climate work. Municipality H expressed that a new act should be developed so that it can be adaptable and used by both small and large municipalities.

5. Discussion

It is found that only 61% of the 290 Swedish municipalities had adopted an EP within the studied time frame, despite the legislative requirement according to the Act on Municipal Energy Planning of having an updated plan for the supply and distribution of energy. Out of those, only 59 municipalities had a Traditional Energy Plan. Furthermore, there was a consensus throughout the interviews that the municipalities no longer have control over the distribution and supply of energy. The results hence confirm that the Act indeed is outdated and that the legislative requirement to have an Energy Plan is more of an encouraging nature, as indicated by, for example, Nilsson and Mårtensson (2003) and Olerup (2000). With the vast majority of the municipalities working proactively by adopting EPCSs and ECSs thus surpassing what is required by the legislation in terms of strategic energy and climate planning, it stands clear that the focus of energy

planning has shifted towards climate change mitigation. This view is reinforced by the interview study. It is thus shown again that local communities are willing to be predecessors in climate issues, and it is expected that both a bottom-up and a top-down approach for climate change mitigation will be beneficial and can aid in obtaining the emissions reductions needed to stay well below 2 °C of global warming. This notion of pioneering municipalities also indicates legitimacy and a wide acceptance for a policy review as proposed by the Swedish Energy Agency, which could pave the way for a smooth implementation and improved legal compliance post any legislative revision.

It can be inferred that the number of annually adopted EPCs and ECSs increased from 2007 onwards and reached a peak in 2009–2012. This peak coincides with the time when all of the major policy instruments with financial incentives were active, which indicates that the programmes were fruitful and led to an increase in the development of EPDs of a more proactive type. According to the interviews, eligibility for funding was also the main reason for initiating the process for three of the eight municipalities. This is consistent with the findings of Lundqvist and Kasa (2016), who concluded that economic incentives have significantly strengthened the local institutionalisation of EPDs. However, the recent decline points towards that the effects of such incentives might drop off after the termination of the programmes. The relative increase of EPCs and ECSs might, however, also be explained in part by the commitment to voluntary initiatives such as the Covenant of Mayors.

The statistical analysis showed that a larger population size was related to a higher probability of both having adopted an EPD within the studied time frame and, if an EPD had been adopted, that the EPD is more up-to-date. A larger population is likely to affect a number of other factors, such as increased tax income, which might enable the municipality to employ at least one energy strategist, perhaps even at full time. In some smaller municipalities, it might also be more difficult to find personnel with the needed competences and skills. This could well be a decisive element for the presence of local climate and energy work and its continuity. For example, one interviewee initiated the process herself, and in other cases where political will sparked the process to develop an EPD, which was the case for half of the interviewed municipalities, there is an evident need for someone to carry out and embody the planning process. One way of addressing this issue could be through collaboration between municipalities, which could encompass the sharing of competences by two or more municipalities together financing a full-time energy strategist position as well as the development of joint EPDs, such as has been the case for five of the Swedish municipalities.

Considering the currentness of the EPD, the results show that slightly less than half (47%) of all of the municipalities had adopted an EPD during the last six years of the study period, 2010–2015, which included the last full term of office (2010–2014). It is suggested by the Swedish Energy Agency (2011) that an assessment of the need for revision of the EPD should occur during each term of office, which hence could increase the continuity of energy planning. It is notable that municipality D has already implemented this requirement voluntarily with procedural success, as their EPD were revised about five years after its adoption. It is discussed by Gustafsson et al. (2015) that a more cyclical and continuous planning process, as opposed to a more project-based approach, can improve the effectiveness of energy planning because the actors might better recognise their responsibility for the implementation of the plan in such a cyclical process. Further, it was suggested by the Swedish Energy Agency (2011) that the amendment of the Act should require that each EPD encompasses an action plan and a plan for monitoring and evaluation. This reflects the current state in the municipalities that were selected for interviews, as seven of the eight municipalities have an action plan or a list of measures either in their EPD or linked to their environmental programme and six of the municipalities have also adopted systematic monitoring, most often on a yearly basis. This outline resembles that of the Sustainable Energy and

Climate Action Plan promoted by the Covenant of Mayors, for which monitoring and evaluation are concluded by Delponte et al. (2017) to be key points for successful implementation. Thus, the imposition of a legislative requirement of this kind not only seems to reflect the current practice, but can also aid when implementing the EPDs and can, along with temporal requirements, further facilitate a more continuous planning process. Moreover, rigid and thorough monitoring and evaluation programmes can, at least in theory, ensure that the proposed action plan is feasible and that one does not end up with a visionary document without any tangible content.

The County Administrative Boards are seemingly influential for municipal energy and climate planning, partly due to the variations between different counties in terms of the propagation of EPDs (which also might partly be attributed to difference in population size), but especially as the interviewees reported that the regional Climate and Energy Strategy had a strong influence on their process, especially concerning targets and strategies. As the CABs attain this quality, their strategic and coordinating energy and climate work in relation to the development of the regional strategies can be a useful platform for co-operation amongst municipalities by addressing inter-municipal energy issues of a strategic nature, such as regional transport, large-scale energy infrastructure, as well as to exchange knowledge and best-practices.

The quantitative study of the influence of EPDs on CPs for the selected 36 municipalities revealed that the EPDs seem potent in influencing the CPs in terms of targets and strategies regarding energy and climate. Even though it was not fully certain that all of the targets originated from the EPD, as some targets could have been established elsewhere within the municipal organisation (e.g. in an environmental programme or as a part of a long-term vision), this still shows a clear relation among the policy documents. With 69% of the studied EPDs including targets or strategies that directly or indirectly involved land use planning in some sense, it seems evident that the need for comprehensive planning to be used as a tool for mitigating climate change is recognised by the municipal energy planners. This is reinforced by the interview study, where all eight municipalities had strategies in their EPD involving land use that either had been or were intended to be incorporated in the CP. These strategies frequently concerned transportation, which also was regarded by the interviewees as the main concern from a climate perspective. Furthermore, there seems to be an exchange in the planning processes, as six interviewees reported that comprehensive planners were involved in the energy planning process and five energy planners participated in the comprehensive planning. For municipality H, this cooperation was taken one step further; a main part of the EPD was to develop strategies for identifying areas for further densification and development that will contribute to a more transport-efficient urban structure, which then were used as direct input and as a basis for the comprehensive planning. All in all, the results show that EPDs have the potential to influence comprehensive planning in terms of considering energy and climate targets and strategies. This is deemed to be positive due to the need for land use planning to be used as a tool for achieving national and EU energy and climate targets, as it can affect the use of energy, the preconditions for production of renewable energy and more. Although the trickling down of these targets and strategies down to detailed development planning has not been studied and no conclusions can be drawn regarding the actual outcome of such planning, it is reasonable to assume that the presence of these targets and strategies in the CP would increase the likelihood for these aspects to be considered in detailed development planning, as the detailed development plan should be conform to the CP. The implementation of the envisioned strategies in order to reach the overarching energy and climate targets in the Detailed Development Plans is hence accentuated as an area to probe further, especially considering the revised Planning and Building Act that, at least theoretically, prohibits municipalities from establishing concrete requirements in this regard on new developments. Furthermore, a continuous

strategic energy and climate planning that is closely related to the comprehensive planning could be one way of providing the sustainability concept some factual content in the comprehensive planning, instead of, as concluded by Persson (2013), internalising the concept into existing practice.

Regarding the cooperation and involvement of stakeholders in the municipal energy planning process, the municipalities seem to differ in their approaches. In general, the actors involved seem to be the ones regarded as the most influential and important for the implementation phase. The local energy companies were involved in the energy planning processes in seven out of the eight interviewed municipalities and were seen as important actors due to their ability to influence the energy system, especially when they were municipally owned. Other actors from the municipal concern, such as municipal administrations, housing companies, and politicians, were commonly involved, and it was made clear in the interviews that gaining legitimacy among these actors is vital for a successful implementation of the EPD. Some municipalities included other stakeholders, such as the public, NGOs, and other private companies, and interviewees D and H emphasised the added value in the process from doing so. Moreover, it is evident from the interviews that the scope of the EPDs varies greatly, often depending on what the municipality has the ability to control. In those instances where energy and housing companies are municipally owned, targets and measures are predominantly included for these stakeholders as well, whereas some other municipalities mostly focus on the internal organisation.

The chosen methodological approach to map the current practice of municipal energy planning in Sweden was to collect all the municipal policy documents focusing on energy and climate that were adopted between 2004 and 2015 and to classify the type of policy document and year of adoption. Although this approach did not give any in-depth analysis in terms of content, targets, or quality, it was found to be useful for analysing wider trends and for providing a broad overview of the present state of energy planning in Swedish municipalities. This can be a useful knowledge basis for policy development at the national level and can enable follow-up after any potential policy interventions regarding municipal energy planning.

6. Conclusions and policy implications

This study has shown that only 61% of the Swedish municipalities adopted an Energy Plan within the time span of 2004–2015. Because the Act on Municipal Energy Planning demands an Energy Plan that is up to date, it is clear that the Act is not being fully complied with. Nor does the Act reflect the current practice because the municipalities are focusing on proactive, strategic energy and climate planning for mitigating climate change and for transitioning to a sustainable energy system rather than planning for the supply and distribution of energy, and many municipalities have lost the influence over the distributional aspects. Hence, the practitioners and the Swedish Energy Agency are calling for a policy revision that acknowledges this new reality. Furthermore, the interviews conducted for this study indicate that the EPDs are providing support and guidance in the officials' everyday work, for example, when considering and prioritising between strategic options or arguing for implementing certain measures. Increased propagation and continuity of municipal energy and climate planning could thus facilitate enhanced local action in relation to climate change. Although the financial incentives from government programmes appear

to have been successful in initiating proactive municipal energy planning, a legislative revision might be needed in order to further increase the propagation, as 27% of all Swedish municipalities were lacking an EPD during the studied time period.

The legislative revision could encompass requirements for municipal ECSs with increased supervision to enhance adherence to the Act. Suggestively, the CABs can be appointed as supervisory authority because they were found to be influential for the municipal planning and they can facilitate coordination and cooperation among municipalities in strategic matters of an inter-municipal nature. Furthermore, a legislative revision can contribute to improved continuity and implementation by having more well-defined temporal requirements as well as certain requirements on the content of the Energy and Climate Strategy, such as to include an action plan combined with monitoring and evaluation. This would make the legislation conform with regards to the proactive energy planning that have been promoted by the national programmes providing financial incentives as well as with voluntary initiatives in Sweden and the EU, e.g. the Covenant of Mayors. There would likely be a positive influence for increased local action if economic incentives are used in combination with legislation that reflects the current practice, with well-defined requirements and the establishment of a supervisory authority, as the results of this study indicate that past financial incentives have spurred an increase in proactive and voluntary energy and climate planning. Either way, it is likely that at least some of the minor municipalities will be in need of financial support in order to have sufficient capacity to continuously conduct strategic energy and climate planning, and this is supported by our finding that a larger population size was found to have a significant and positive influence both on the propagation and the currentness of the EPDs.

Furthermore, the EPDs have the potential to be a vital instrument for ensuring the consideration of energy and climate targets and strategies in the Comprehensive Plan, which provides guidance for land use and thus can affect the transportation demand in relation to urban structures, the preconditions for energy production, the utilisation of heating sources, and so on. The EPDs can thereby aid to bring the concept of sustainability some more tangible and concrete content in the CP. Land use planning is seen as a key tool for achieving Swedish climate targets, especially in relation to a carbon-neutral transport sector. As the Swedish municipalities maintain great autonomy, this relation is deemed vital for attaining a more sustainability-led municipal planning that contributes to reaching the national objectives, which theoretically should infuse the detailed development planning. It would thus be important to strengthen the relation between strategic municipal energy planning and municipal comprehensive planning in any future policy revisions.

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Appendix A

See Tables A1 and A2

Table A1
Summary of results from interviews with municipal officials.

Municipality	A	B	C	D
	Background data			
Approximate population	80,000	500,000	10,000	20,000
Municipality type	2 - Suburban municipalities	1 - Metropolitan municipalities	4 - Suburban municipalities to large cities	7 - Manufacturing municipalities
EPD adopted (year)	2014	2014	2013	2015
Title of EPD	Climate and Energy Strategy	Climate Strategic Programme	Energy and Climate Plan	Energy Plan - Energy and Climate Strategy
Type of EPD	EPCS	EPCS	EPCS	EPCS
Job title of interviewee	Climate and environmental strategist	Environmental inspector	Energy and climate advisor	Environmental strategist
How the Energy Planning Document functions	<p>The EPD is a well-known policy document that all the boards and the municipal housing company should follow. The overarching climate target is also a part of the municipality's steering model, and all of the boards should produce their own strategy showing how to meet the targets. The EPD can be a support when producing measures. It is followed-up yearly in the annual report and in an internal follow-up only for the EPD.</p>	<p>The experience of the interviewee is that for people who want to take action, one can take support in the EPD when arguing for measures and investments. However, the EPD is a strategic and visionary document that does not include any concrete measures, and it is therefore difficult to follow up.</p> <p>Results from interviews</p>	<p>The interviewee says that it can be a challenge to make municipal officials aware of the EPD, and that it is to a large degree up to the energy strategist to communicate and represent these matters. A list of measures along with the responsible administrations is followed-up on a yearly basis, and the targets might be revised if needed.</p>	<p>The EPD is a strategic tool that guides municipality D in their actions. The document has wide political support and the politicians regularly ask about the progress. Because it has such legitimacy, the strategist can take support in the EPD in the daily work. The document is followed-up in the annual report and the plan should be considered by the municipal council at least once during each term of office, just as the Comprehensive Plan should be according to the Planning and Building Act.</p>
The planning process	<p>The EPD was developed with an inter-administrational working group, overseen by the environmental committee. The municipal housing company and the private energy company were also involved in the process. Climate targets on the national level were considered, and the focus areas correspond to the regional Climate and Energy Planning Document.</p>	<p>All the concerned administrations, municipal companies, NGOs, and researchers were invited and then divided into three working groups – consumption, transport, and energy. These working groups developed targets and strategies for each focus area. A steering group with directors was also in place. The regional and national targets were considered to ensure that the municipal targets were not conflicting.</p>	<p>The focus areas and targets were set through two workshops. Different internal and external stakeholders participated in the first workshop, where different focus areas were identified. In the second workshop, the targets were set in collaboration between different concerned administrations and a consultant. When establishing the targets, national and regional targets were considered.</p>	<p>It was early decided that the scope of this EPD should be a bit narrower, as the previous one was very comprehensive and led to difficulties in follow-up. Politicians were involved in an early stage and had a debate regarding what to include in the Energy Plan, then the working group discussed targets and strategies with the political steering group. Targets at the national level as well as regional action plans were considered. The working group consisted of the energy strategist, the environmental strategist, and an environmental coordinator from the municipally owned technical company.</p>
Integration to spatial planning	<p>According to the interviewee, the EPD states how energy issues should be considered in spatial planning, which mainly is to localise new development within close proximity to public transport and to promote modes of active travel, and these standpoints should be integrated into the Comprehensive Plan. The comprehensive planners are part of the same administration as the climate and environmental strategist.</p>	<p>The interviewee says that the EPD should be integrated into the Comprehensive Plan. The Environmental administration is also consulted for Detailed Development Plans as well as in the development of new city districts to ensure that the proposed development is in line with the EPD.</p>	<p>The interviewee expresses that many of the raised issues that are stated in the EPD have been included in the Comprehensive Plan. The energy strategist participated in the comprehensive planning process and vice versa, and the project leader for developing the Comprehensive Plan participated in the process for developing the EPD. The ecological administration and the administration of the built environment are also situated very close to each other and meet informally on a daily basis.</p>	<p>The preceding EPD had contained some strategies for integrating energy efficiency in spatial planning, which then were incorporated into the following Comprehensive Plan. Similar measures were therefore excluded in the current EPD. However, the interviewee was a part of the working group of the Comprehensive Plan, and the energy and climate strategist of the municipality is also situated at the unit for land use planning.</p>

Table A2
Cont. of summary of results from interviews with municipal officials.

Municipality	E	F	Background data	G	H
Approximate population	80,000	10,000		60,000	100,000
Municipality type	3- Large cities	2 - Suburban municipalities		3- Large cities	3- Large cities
EPD adopted (year)	2011	2015		2012	2015
Title of EPD	Climate Strategy and Energy Plan	Energy Plan		Energy and Climate Programme	Energy and Climate Strategy
Type of EPD	EPCS	TEP		EPCS	ECS
Job title of interviewee	E1 - Climate strategist, E2 - Planning architect	Environmental strategist		Environmental investigator	Energy coordinator
How the Energy Planning Document functions	Interviewee E1 finds the EPD to be vital because it stipulates the targets that the municipality has established, as well as an action plan with an established time-line and responsible bodies for each action. The EPD is followed-up on a yearly basis.	It is up to the interviewee to bear the message of the Energy Plan and to inspire actions. And because the EPD has been adopted by the politicians, it is much easier to get the measures in the action plan to be prioritised. The intention is to follow-up the energy plan each year; however, this have not happened yet. Some of the performed actions have anyhow been included in the municipality's sustainability report.	Results from interviews	The EPD is an important document that should guide the development of the municipality. However, the interviewee does not have that much direct influence in the daily operations of other administrations or municipally owned companies. It is anyhow regarded that the municipal energy company operates more or less in line with the EPD. Follow-up is done, but not in a yearly manner as was previously planned.	It can be used as a reference material and as guidance when taking strategic decisions regarding future development, and even though it does not have an action plan, the interviewee thinks that it is a helpful tool in these settings. The municipality also has an internal climate compensation scheme in place, where 1 SEK per emitted kg of CO ₂ is marked for measures to reduce emissions. It is up to the administrations to decide upon which actions to take, but the interviewee is consulted in the process.
The planning process	An energy group was established even before the process of developing the EPD was initiated, consisting of representatives from the concerned administrations as well as the municipally owned energy and housing companies. This group was also the main working group during the process, but a hearing with other internal and external stakeholders was also held. Mostly regional, but also national targets were considered in the process.	Before, there was no EPD in the municipality, and the interviewee felt that one could not push through any measures or strategies, and therefore decided to initiate the process. A political steering group was involved in the process, and it was decided that one would adopt the targets from the regional climate strategy. The working group consisted of the chief of land use planning and an employee from the technical department.		When the municipal executive board instructed that the EPD should be developed, the County Administrative Board started a project to support municipalities to develop a strategy. A lot of the strategies and formulations are hence originating from the regional strategy. The working group consisted of representatives from the municipal housing company and the municipal energy company and the administration of the built environment.	Scenarios were developed during workshops with representatives from most administrations and municipal companies. They were then assessed according to some previously defined sustainability criteria. After input from politicians, the scenarios were then refined into a vision, which was used in the development of the Comprehensive Plan. Furthermore, strategies that should lead to the fulfilment of the vision were developed, and then it was up to each administration to develop actions that are in line with these strategies.
Integration to spatial planning	During the planning process of the Comprehensive Plan, interviewee E1 was consulted regarding integrating energy consideration in spatial planning, and some formulations from the EPD were included. There was, however, an ongoing debate regarding the localisation of new developments, where some were opposing that all new development should be localised close to public transport, as the municipality wants to be able to offer more secluded housing as well so that the demands of all inhabitants can be met.	The Comprehensive Plan was developed before the EPD, and the strategist was merely participating in some seminars. Once a meeting the municipal administrations have a meeting regarding land use planning, and then the strategist is participating. The cooperation could, however, be strengthened further with a new project model where sustainability issues is integrated earlier in the process.		When the Comprehensive Plan was developed, the interviewee was not a participant. Some formulations regarding energy efficient development that originates from the strategy was, however, included in the plan. The interviewee is involved in the current process of developing a detailed Comprehensive Plan for the main city of the municipality.	The energy planning process was initiated with the intention of incorporating energy aspects into spatial planning, and the urban planner that was a part of the working group simultaneously had the responsibility to produce a Comprehensive Plan. The interviewee is also a part of the working group for the Comprehensive Plan, and standpoints from the EPD are incorporated in the draft of the plan.

Appendix B

Propagation and population size

In order to investigate whether there is any difference in terms of population size between municipalities whom have adopted at least one EPD during the studied time span versus the ones that have not, a two-tailed Wilcoxon rank-sum test (a.k.a. Mann-Whitney *U* test) was used. This statistical test was chosen as it is a non-parametric test that, unlike an unpaired two sample student's *t*-test, does not assume normality in its studied samples. As can be seen in Table B1, with the SD being larger than the mean value, normality is not met.

H_0 : the median value of the two groups are equal.

H_1 : the median value of the two groups are different (two-tailed).

The wilcox.test() function in R returned $W = 5902$, $p\text{-value} = 0.00024$. As the p -value is lower than $\alpha = 0.05$, H_0 is rejected and H_1 is accepted.

Table B1

Descriptive statistics concerning population size for the municipalities with at least one EPD compared to municipalities without EPD.

	Municipalities with at least one EPD	Municipalities without EPD
Mean	36 441	20 467
Median	18 505	11 943
Standard deviation	72 517	25 233
Number of municipalities	213	77

Currentness and population size

For the selection of municipalities that have adopted at least one EPD, it was examined if there was any difference in population size for municipalities that had adopted an EPD during 2004–2009 compared to the municipalities with an EPD adopted during 2010–2015. If multiple EPDs had been adopted of a municipality, the last temporal value was used. A two-tailed Wilcoxon rank-sum test was used for this question as well, as the normality requirements for a linear regression (e.g. concerning skewness and kurtosis) was not met. In Table B2, some descriptive statistics of the unpaired samples are found.

H_0 : the median value of the two groups are equal.

H_1 : the median value of the two groups are different (two-tailed).

The wilcox.test() function in R returned $W = 3985$, $p\text{-value} = 0.003$. As the p -value is lower than $\alpha = 0.05$, H_0 is rejected and H_1 is accepted.

Table B2

Descriptive statistics concerning population size for the municipalities with an EPD adopted during 2004–2009 compared to municipalities with an EPD adopted during 2010–2015.

	Municipalities with an EPD adopted during 2004–2009	Municipalities with an EPD adopted during 2010–2015
Mean	24 679	43 517
Median	14 252	23 915
Standard deviation	37 371	86 751
Number of municipalities	78	135

References

- 1977:439, 1977. Lag om kommunal energiplanering, Swedish Code of Statutes.
- 2009:1533, 2009. Förordning (2009:1533) om statligt stöd till energieffektivisering i kommuner och landsting, Swedish Code of Statutes.
- 2010:900, 2010. Plan- och bygglag, Swedish Code of Statutes.
- 2014:900, 2015. Lag om ändring i plan- och bygglagen (2010:900), Swedish Code of Statutes.
- Anderson, W.P., Kanaroglou, P.S., Miller, E.J., 1996. Urban form, energy and the environment: a review of issues, Evidence and Policy. *Urban Stud.* 33, 7–35. <http://dx.doi.org/10.1080/00420989650012095>.
- Aneby Municipality, 2011. Aneby kommuns Energi- och kl imatstrategi.
- Azevedo, I., Delarue, E., Meeus, L., 2013. Mobilizing cities towards a low-carbon future: tambourines, carrots and sticks. *Energy Policy* 61, 894–900. <http://dx.doi.org/10.1016/j.enpol.2013.06.065>.
- Bryman, A., 2012. *Social Research Methods*, 4th ed. Oxford University Press, Oxford.
- Byström, G., Wretling, V., 2016. *Strategic Municipal Energy Planning—Examining Current Practice in Sweden* (Master's Thesis). KTH Royal Institute of Technology, Stockholm.
- Covenant of Mayors for Climate & Energy, 2017a. Covenant of Mayors for Climate & Energy [WWW Document]. URL http://www.covenantofmayors.eu/about/covenant-of-mayors_en.html (accessed 24 August 2017).
- Covenant of Mayors for Climate & Energy, 2017b. Covenant in figures [WWW Document]. URL http://www.covenantofmayors.eu/about/covenant-in-figures_en.html (accessed 16 August 2017).
- Damsø, T., Kjaer, T., Christensen, T.B., 2016. Local climate action plans in climate change mitigation-examining the case of Denmark. *Energy Policy* 89, 74–83.
- Delponte, I., Pittaluga, I., Schenone, C., 2017. Monitoring and evaluation of Sustainable Energy Action Plan: practice and perspective. *Energy Policy* 100, 9–17. <http://dx.doi.org/10.1016/j.enpol.2016.10.003>.
- Elbakidze, M., Dawson, L., Andersson, K., Axelsson, R., Angelstam, P., Stjernquist, I., Teitelbaum, S., Schlyter, P., Thellbro, C., 2015. Is spatial planning a collaborative learning process? A case study from a rural–urban gradient in Sweden. *Land Use Policy* 48, 270–285. <http://dx.doi.org/10.1016/j.landusepol.2015.05.001>.
- EU Directive 2009/28/EC, 2009. Directive 2009/28/EC of the European Parliament and of the Council of 23 April 2009 on the promotion of the use of energy from renewable sources and amending and subsequently repealing Directives 2001/77/EC and 2003/30/EC. OJ L 140, 16–62.
- EU Directive 2012/27/EU, 2012. Directive 2012/27/EU of the European Parliament and of the Council of 25 October 2012 on energy efficiency, amending Directives 2009/

- 125/EC and 2010/30/EU and repealing Directives 2004/8/EC and 2006/32/EC. OJ L 315, 1–56.
- Fenton, P., Gustafsson, S., Ivner, J., Palm, J., 2015. Sustainable energy and climate strategies: lessons from planning processes in five municipalities. *J. Clean. Prod.* 98, 213–221. <http://dx.doi.org/10.1016/j.jclepro.2014.08.001>.
- Finspång Municipality, 2009. Energiplan.
- Forsåga Municipality, 2009. Klimat- och energistrategi.
- Fragkos, P., Tasios, N., Paroussos, L., Capros, P., Tsani, S., 2017. Energy system impacts and policy implications of the European intended nationally determined contribution and low-carbon pathway to 2050. *Energy Policy* 100, 216–226. <http://dx.doi.org/10.1016/j.enpol.2016.10.023>.
- Government and Government Offices of Sweden, 2017. Det klimatpolitiska ramverket [WWW Document]. Regeringskansliet. URL <http://www.regeringen.se/artiklar/2017/06/det-klimatpolitiska-ramverket/> (accessed 15 August 2017).
- Government Bill 1975:30, 1975. Regeringens proposition om energihushållningen m.m. Government of Sweden.
- Government Bill 2008/09:162, 2009. En sammanhållen klimat- och energipolitik - Klimat. Government of Sweden.
- Government Bill 2008/09:163, 2009. En sammanhållen klimat- och energipolitik - Energi. Government of Sweden.
- Government Bill 2016/17:146, 2017. Ett klimatpolitiskt ramverk för Sverige. Government of Sweden.
- Granberg, M., Elander, I., 2007. Local governance and climate change: reflections on the Swedish experience. *Local Environ.* 12, 537–548. <http://dx.doi.org/10.1080/13549830701656911>.
- Gustafsson, S., Ivner, J., Johansson, L., Palm, J., 2011. Översiktlig kartläggning av kommuners erfarenheter kring energi- och klimatstrategiarbete en enkätstudie. Linköping University Electronic Press, Linköping.
- Gustafsson, S., Ivner, J., Palm, J., 2015. Management and stakeholder participation in local strategic energy planning –Examples from Sweden. *J. Clean. Prod., Spec. Vol.: Support your Future Today! Turn. Environ. Chall. into Oppor.* 98, 205–212. <http://dx.doi.org/10.1016/j.jclepro.2014.08.014>.
- Henning, D., Danestig, M., 2008. Energifrågor i fysisk planering: förutsättningar och scenarier för energitillförsell och energihushållning, ER / Energimyndigheten, 1403–1892; 2008:03. Statens energimyndighet, Eskilstuna.
- Hjo Municipality, 2007. Energiplan.
- Högselius, P., Kaijser, A., 2010. The politics of electricity deregulation in Sweden: the art of acting on multiple arenas. *Energy. Policy, Gt. China Energy.: Spec. Sect. Regul. Pap.* 38, 2245–2254. <http://dx.doi.org/10.1016/j.enpol.2009.12.012>.
- Hultsfred Municipality, 2008. Energiplan.
- International Energy Agency, 2015. Energy and Climate Change - World Energy Outlook Special Report. International Energy Agency, Paris.
- IPCC, 2011. Special Report on Renewable Energy Sources and Climate Change Mitigation. Intergovernmental Panel on Climate Change.
- Jokkmokk Municipality, 2009. Energiplan och kl imatstrategi.
- Kanellakis, M., Martinopoulos, G., Zachariadis, T., 2013. European energy policy—a review. *Energy Policy* 62, 1020–1030. <http://dx.doi.org/10.1016/j.enpol.2013.08.008>.
- Kaza, N., Curtis, M.P., 2014. The land use energy connection. *CPL Bibliogr.* 29, 355–369. <http://dx.doi.org/10.1177/0885412214542049>.
- Kil Municipality, 2008. Klimat- och energiplan för Kils kommun.
- Klimatkommunerna, 2015. Medlemskap [WWW Document]. Klimatkommunerna. URL <http://www.klimatkommunerna.se/Om-klimatkommunerna/Medlemskap/> (accessed 16 August 2017).
- Kvale, S., 2014. Den kvalitativa forskningsintervju, 3. [rev.] uppl. ed. Studentlitteratur, Lund.
- Lundqvist, L.J., Kasa, S., 2016. Between national soft regulations and strong economic incentives: local climate and energy strategies in Sweden. *J. Environ. Plan. Manag.* 0, 1–20. <http://dx.doi.org/10.1080/09640568.2016.1197827>.
- Lundström, M.J., 2010. Planering Och Hållbar Bebyggelseutveckling i Ett Energi- Och klimatperspektiv (Licentiate Thesis). Royal Institute of Technology, Stockholm.
- Månsson, A., 2016. Energy security in a decarbonised transport sector: A scenario based analysis of Sweden's transport strategies. *Energy Strategy Rev.* 13, 236–247. <http://dx.doi.org/10.1016/j.esr.2016.06.004>.
- Nässjö Municipality, 2012. Energi- och kl imatstrategi.
- Nilsson, J.S., Mårtensson, A., 2003. Municipal energy-planning and development of local energy-systems. *Appl. Energy* 76, 179–187. [http://dx.doi.org/10.1016/S0306-2619\(03\)00062-X](http://dx.doi.org/10.1016/S0306-2619(03)00062-X).
- Nyköping Municipality, 2010. Energiplan.
- Official Letter 2015/16:87, 2016. Kontrollstation för de klimat- och energipolitiska målen till 2020 samt klimatanpassning. The Government of Sweden.
- Olerup, B., 2000. Scale Scope Munic. Energy Plan. *Swed.* 43, 205–220. <http://dx.doi.org/10.1080/09640560010676>.
- Orust Municipality, 2007. Energi- och kl imatplan.
- Palm, J., 2006. Development of sustainable energy systems in Swedish municipalities: a matter of path dependency and power relations. *Local Environ.* 11, 445–457. <http://dx.doi.org/10.1080/13549830600785613>.
- Palm, J., 2004. Makten över Energin-Policyprocesser i två Kommuner 1977–2001. Linköping University, The Tema Institute, Technology and Social Change. Linköping University, Faculty of Arts and Sciences, Linköping.
- Palm, J., Thoreson, J., 2014. Strategies and implications for network participation in regional climate and energy planning. *J. Environ. Policy Plan.* 16, 3–19. <http://dx.doi.org/10.1080/1523908X.2013.807212>.
- Pasimeni, M.R., Petrosillo, I., Aretano, R., Semeraro, T., De Marco, A., Zaccarelli, N., Zurlini, G., 2014. Scales, strategies and actions for effective energy planning: a review. *Energy Policy* 65, 165–174. <http://dx.doi.org/10.1016/j.enpol.2013.10.027>.
- Persson, C., 2013. Deliberation or doctrine? Land use and spatial planning for sustainable development in Sweden. *Land Use Policy* 34, 301–313. <http://dx.doi.org/10.1016/j.landusepol.2013.04.007>.
- QSR International, 2012. NVivo qualitative data analysis Software.
- R Core Team, 2017. R: A language and environment for statistical computing. Vienna, Austria.
- Ranhagen, U., 2013. Att Integrera Hållbarhets- Och Energifrågor i Fysisk Planering - Metoder och Verktyg. The Swedish Energy Agency.
- Ranhagen, U., 2011. Uthållig Kommun - Fyra Stora och Tjugo små Steg: Idéskrift om Fysisk Planering. Swedish Energy Agency, Eskilstuna.
- Rogelj, J., den Elzen, M., Höhne, N., Fransen, T., Fekete, H., Winkler, H., Schaeffer, R., Sha, F., Riahi, K., Meinshausen, M., 2016. Paris Agreement climate proposals need a boost to keep warming well below 2 °C. *Nature* 534, 631–639. <http://dx.doi.org/10.1038/nature18307>.
- Salon, D., Murphy, S., Sciarra, G.-C., 2014. Local climate action: motives, enabling factors and barriers. *Carbon Manag.* 5, 67–79. <http://dx.doi.org/10.4155/cmt.13.81>.
- Säter Municipality, 2010. Energi- och kl imatstrategi.
- SPEAK, 2015. Dataset of collected documents.
- Statistics Sweden, 2016. Län och kommuner i kodnummerordning [WWW Document]. Stat. Swed. URL <http://www.scb.se/sv/Hitta-statistik/Regional-statistik-och-kartor/Regionala-indelningar/Lan-och-kommuner/Lan-och-kommuner-i-kodnummerordning/> (accessed 30 August 2016).
- Stenlund Nilsson Ivner, J., 2006. Plan and Reality Municipal Energy Plans and Development of Local Energy Systems. Linköping University Electronic Press, Linköping.
- Strambo, C., Nilsson, M., Månsson, A., 2015. Coherent or inconsistent? Assessing energy security and climate policy interaction within the European Union. *Energy Res. Soc. Sci.* 8, 1–12. <http://dx.doi.org/10.1016/j.erss.2015.04.004>.
- Swedish Association of Local Authorities and Regions, 2014. Översiktsplanen i praktiken. Stockholm.
- Swedish Energy Agency, 2015a. Statligt stöd till energieffektivisering i kommuner och landsting [WWW Document]. URL <http://www.energimyndigheten.se/energieffektivisering/program-och-uppdrag/avslutade-program/Statligt-stod-till-energieffektivisering-i-kommuner-och-landsting/> (accessed 1 April 2017).
- Swedish Energy Agency, 2015b. 1,5 miljarder mindre i energikostnader [WWW Document]. URL <http://www.energimyndigheten.se/nyhetsarkiv/2015/15-miljarder-mindre-i-energieffektivisering/> (accessed 1 April 2017).
- Swedish Energy Agency, 2011. Aktualisering av Lagen om Kommunal Energiplanering. Swedish Energy Agency.
- Swedish Environmental Protection Agency, 2015. Mål i sikte [Elektronisk resurs] Analys och bedömning av de 16 miljökvalitetsmålen i fördjupad utvärdering 2015. Stockholm.
- Swedish Environmental Protection Agency, 2013. Klimatinvesteringsprogrammen Klimp 2003–2012: slutrapport - redovisning till regeringen januari 2013. Swedish Environmental Protection Agency, Stockholm.
- Swedish Environmental Protection Agency, 2012. Underlag till en färdplan för ett Sverige utan klimatutsläpp 2050. Swedish Environmental Protection Agency, Stockholm.
- Swedish Environmental Protection Agency, 2010. Gör arbetet med klimatstrategier någon skillnad? En utvärdering av lokalt klimatstrategiarbete. Naturvårdsverket, Stockholm.
- Swedish Government Official Reports 2008:110, 2008. Vägen till ett energieffektivare Sverige: slutbetänkande. Stockholm.
- Swedish Transport Administration, 2015. Trafikverkets Kunskapsunderlag och Klimatscenario för Energieffektivisering och Begränsad klimatpåverkan. Swedish Transport Administration.
- Trollhättan Municipality, 2012. Energiplan.
- UN, 1992. Earth Summit Agenda 21–The United Nations Programme of Action from Rio. United Nations Publication no. E.93.I.11. United Nations Department of Public Information, New York.
- van Staden, M., Musco, F., 2010. Local Governments and Climate Change: Sustainable Energy Planning and Implementation in Small and Medium Sized Communities, *Advances in Global Change Research*. Springer, Netherlands, Dordrecht.
- Wallström, J., 2015. Mapping of current Swedish Environmental Assessment practice - a statistical analysis. SPEAK.